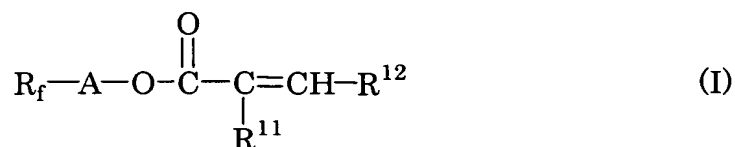


CLAIMS

1. A fluorine-containing copolymer comprising

(a) 50 to 92 % by weight of at least one

5 fluoromonomer of the general formula:

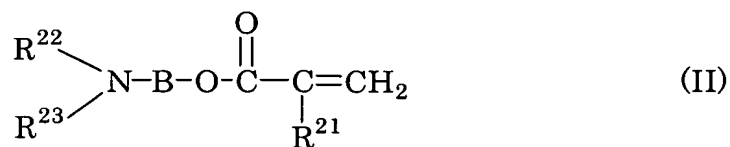


wherein R_f represents a linear or branched fluoroalkyl group having 1 to 21 carbon atoms, preferably 4 to 16 carbon atoms,

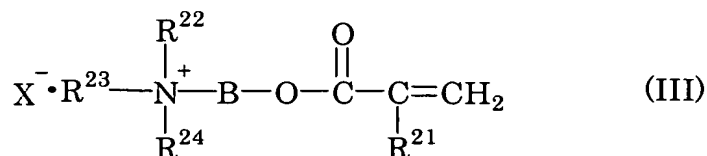
A represents a divalent organic group having a carbon atom to be bonded to an oxygen atom adjacent to the group A, and
10 if needed, at least one oxygen atom, sulfur atom and/or nitrogen atom,

one of R¹¹ and R¹² represents a hydrogen atom, and the other thereof represents a hydrogen atom or an alkyl group having
15 1 to 4 carbon atoms;

(b) 1 to 25 % by weight of at least one nitrogen-containing monomer of the general formula:



and/or

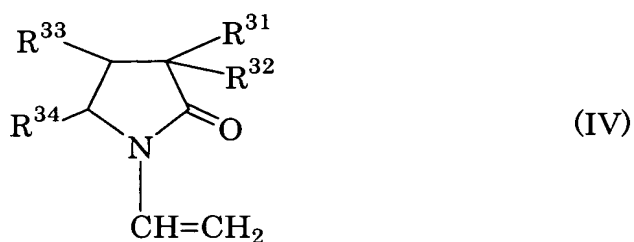


wherein B represents a linear or branched alkylene group
20 having 1 to 4 carbon atoms,

R²¹ represents a hydrogen atom or an alkyl group having 1 to 4 carbon atoms,

R^{22} , R^{23} and R^{24} are the same or different, each representing a hydrogen atom, a linear or branched alkyl group having 1 to 18 carbon atoms, or a hydroxyethyl group or a benzyl group; or otherwise, R^{22} and R^{23} together form a divalent organic group having 2 to 30 carbon atoms, and X^- represents an anionic group;

(c) 1 to 25 % by weight of a pyrrolidone monomer of the general formula:



wherein R^{31} , R^{32} , R^{33} and R^{34} are the same or different, each representing a hydrogen atom or an alkyl group having 1 to 4 carbon atoms; and

(d) 1 to 5 % by weight of a monomer having an anionic functional group.

2. A copolymer according to claim 1, further comprising

(e) 0 to 10 % by weight of a monomer other than the monomers (a), (b), (c) and (d).

3. A copolymer according to claim 1, wherein said fluoromonomer (a) is at least one fluoromonomer of the formula (I) in which R_f represents a perfluoroalkyl group having 4 to 16 carbon atoms.

4. A copolymer according to claim 1, wherein said nitrogen-containing monomer (b) is dimethylaminoethyl methacrylate,

dimethylaminopropyl methacrylate, diethylaminoethyl methacrylate, diethylaminopropyl methacrylate, N-tert.-butylaminoethyl methacrylate, dimethylaminoethyl acrylate, dimethylaminopropyl acrylate, diethylaminoethyl acrylate, 5 diethylaminopropyl acrylate, N-tert.-butylaminoethyl acrylate, or a mixture thereof.

5. A copolymer according to claim 1, wherein said pyrrolidone monomer (c) is N-vinyl-2-pyrrolidone, N-vinyl-10 3-methyl-2-pyrrolidone, N-vinyl-4-methyl-2-pyrrolidone, N-vinyl-5-methyl-2-pyrrolidone, N-vinyl-3,3-dimethyl-2-pyrrolidone, or a mixture thereof.

6. A copolymer according to claim 1, wherein said anionic 15 functional group-containing monomer (d) is acrylic acid, methacrylic acid, sodium styrene sulfonate, itaconic acid, fumaric acid, or a mixture thereof.

7. A copolymer according to claim 1, wherein said 20 fluoromonomer (a) is at least one fluoromonomer of the formula (I) in which R_f represents a perfluoroalkyl group having 4 to 16 carbon atoms; said nitrogen-containing monomer (b) is dimethylaminoethyl methacrylate; said pyrrolidone monomer (c) is N-vinylpyrrolidone; and said 25 anionic functional group-containing monomer (d) is methacrylic acid.

8. A copolymer according to claim 1, wherein said fluoromonomer (a) is a compound of the formula:

F(CF₂)₈CH₂CH₂OCOCH=CH₂ or F(CF₂)₁₀CH₂CH₂OCOCH=CH₂, or a mixture thereof; said nitrogen-containing monomer (b) is dimethylaminoethyl methacrylate; said pyrrolidone monomer (c) is N-vinylpyrrolidone; and said anionic functional group-containing monomer (d) is methacrylic acid.

9. A copolymer according to claim 1, wherein said fluoromonomer (a) is a mixture of a compound of the formula: F(CF₂)₈CH₂CH₂OCOCH=CH₂ and a compound of the formula: F(CF₂)₁₀CH₂CH₂OCOCH=CH₂; said nitrogen-containing monomer (b) is dimethylaminoethyl methacrylate; said pyrrolidone monomer (c) is N-vinylpyrrolidone; and said anionic functional group-containing monomer (d) is methacrylic acid, and wherein the weight ratio of these monomers is 66 : 14 : 15 : 3 : 2.

10. A method for using a copolymer according to any one of claims 1 to 9, for treating a solid substrate, particularly paper and cardboard to impart lipophobic property and hydrophobic property thereto.

11. A paper treatment agent comprising a copolymer according to any one of claims 1 to 9.

12. A paper treatment agent according to claim 11, which is applied to the surface of paper in such an amount that the ratio of the weight of fluorine atoms in the agent to the weight of the paper can be 0.05 to 0.2 % by weight.

13. A paper treatment agent according to claim 11, which is applied to a whole of paper including the internal layer thereof, in such an amount that the ratio of fluorine atoms in the agent to the weight of pulp can be 0.2 to 0.4 % by weight.

14. Processed paper treated with a paper treatment agent according to any one of claims 11 to 13.

15. A process for preparing a copolymer according to claim 1, comprising the steps of copolymerizing the monomers (a), (b), (c) and (d) in a water-soluble organic solvent or a solution of a mixture of water-soluble organic solvents, and if needed, diluting the copolymer with an aqueous solution of an inorganic or organic acid.

16. A process for preparing a copolymer according to claim 1, comprising the steps of previously neutralizing the nitrogen-containing monomer with an acid, and polymerizing the monomers.

17. A process according to claim 15 or 16, wherein the copolymer is treated with an aqueous solution of hydrogen peroxide after the polymerization.

18. A process according to any one of claims 15 to 17, wherein the amount of hydrogen peroxide is 0.1 to 10%, preferably 0.3 to 3% based on the total weight of the monomers.

19. A process according to any one of claims 15 to 18, wherein the solvent for use in the copolymerization is N-methyl-2-pyrrolidone.

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20. A process according to any one of claims 15 to 18, wherein the solvent for use in the copolymerization is acetone, acetonitrile, methanol, or a mixture thereof.

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21. A process according to claim 15, wherein the acid in the aqueous organic acid solution is acetic acid.

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22. A process for preparing a copolymer according to claim 1, comprising the steps of copolymerizing the monomers (a), (b), (c) and (d) in acetone, acetonitrile, methanol, or a mixture thereof, and if needed, diluting the copolymer with an aqueous solution of an inorganic or organic acid, and then distilling off the organic solvent.